Space Weather Technical Forecast

Issued on Wednesday 26 February 2025 at 00:16 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares likely. Slight chance G1/Minor Storms, mainly Day 3 (28 Feb). Declining chance of S1/Minor Radiation Storm.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with three M-class flares. A long duration flare from over the western limb peaked at 24/2306 UTC and was still M-class at the start of the 24 hour period. A further long duration M3.6 was observed peaking at 25/1159 UTC, from the region of AR3998 and the trailer of AR3996.

There are now eight sunspot regions on the visible disc. The largest and most notable is AR3998 in the southwest, which is comprised of a number of small umbra, but maintains a larger bipolar configuration. There has been a slight loss of penumbral area, but a slight increase in length, with the leading spots in particular coalescing into a larger spot. The other regions of main interest include AR4000 in the northwest, but this continues to fade slowly. AR4006 in the northeast is also of note, with some intermediate spot development, but so far remains a relatively small region with only minor magnetic complexity. Other regions appear smaller and simple at the present time.

The M3.6 flare produced a CME, but this has been assessed as missing Earth. No Earth directed CMEs were seen in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, showed some weak CME influence. Wind speed eased from slightly elevated levels near 430km/s to background levels around 330 km/s. Density was average or above, perhaps peaking at 51ppcc at 25/0631 UTC. Interplanetary Magnetic Field, Bt, was mostly moderate, initially at 15nT, but very soon easing to range between 4-13nT. This was initially mainly northward, but erratically became more southward directed, varying between +13/-11nT. Phi angle was positive (away from the Sun) at first, erratically switching negative (towards the Sun) from around 25/0600 UTC. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 rose above the S1/Minor Radiation Storm threshold between 25/0020-1125 UTC, with peak 37 pfu at 25/0240 UTC, but has since been declining. The 24-hour fluence was below the Active threshold (1e8 integrated pfu), recording 1.23e6 integrated pfu at 26/0000UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: M-flares are considered likely with a slight chance of X-flares, this risk reducing during the period as regions rotate off the disc.

Solar Wind / Geomagnetic Activity: A CME from the M3.3 flare and associated filament eruption on 24 Feb was largely obscured in coronagraph imagery by a far side CME, making assessment difficult, however a glancing influence cannot be completely ruled out, most likely during Day 2 (27 Feb). Solar winds at Earth are currently showing some weak CME influence. The main upcoming enhancement from CH19/+ is likely on Days 2-3 (27-28 Feb), with wind speeds of over 600km/s expected. Wind speeds are likely to remain elevated or strong for the rest of the period, once the fast wind connects with Earth.

Generally Quiet to Unsettled geomagnetic activity is expected. Active intervals are possible however, along with a slight chance of G1/Minor Storm intervals, from CME influence on Days 1-2, as well as any coronal hole fast wind onset, particularly Days 2-3.

Energetic Particles / Solar Radiation: High energy proton flux is currently just below the S1 Minor Storm level, and is expected to continue declining towards background. There remains a reducing chance of renewed enhancements if any further far-sided activity occurs, with a continuing slight chance from regions in the west of the Earth facing disc. High energy electron flux is expected to be mainly at background. The associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

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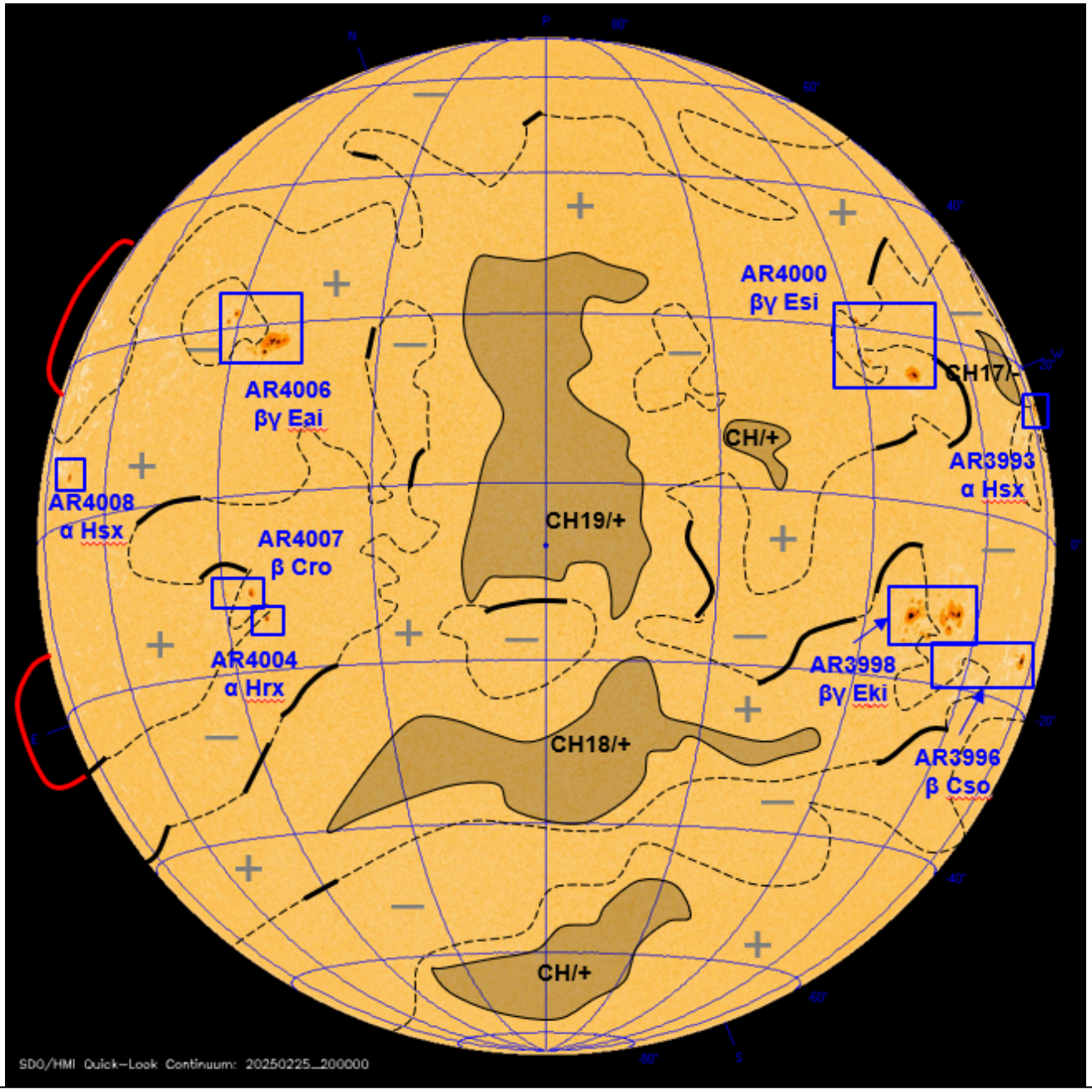
Figure 1: Solar synoptic map, valid 25/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A fast and bright CME off the northwest on 24 Feb obscures a much weaker and fainter signal from the M3.3 flare and associated filament eruption. This signal is identifiable on STEREO A cor2 difference imagery, and this is likely missing north and ahead of Earth's orbit. However, due to the contamination from the far-side event, this assessment is low confidence, and a glancing influence cannot be completely ruled out, most likely to occur during Day 2 (27 Feb).

Solar winds at Earth are currently at slow speeds, but with a moderate IMF, likely due to weak CME influence. There are a large number of coronal hole features currently on the Earth-facing disc. However, aside from CH17/- in the northwest, all the features are positive polarity coronal holes which are less favoured for strong a geomagnetic connection to Earth as we move closer to the March Equinox. An initial enhancement is possible from the small and currently unnumbered leading regions, perhaps though Day 1 (26 Feb), but wind speeds are unlikely to go much above 400-450 km/s. A further enhancement is then likely on Days 2-3 (27-28 Feb), due to the onset of any fast wind from CH19/+ (and CH18/+ in the south). This is a larger and more notable feature, and last rotation brought solar wind speeds of over 600km/s, but only Active geomagnetic activity. Despite the proximity of the equinox, the persistence of this feature suggests similar can be expected on this occasion. Wind speeds are likely to remain elevated or strong for the rest of the period, once the fast wind connects with Earth.

Generally Quiet to Unsettled geomagnetic activity is expected. Active intervals are possible however, along with a slight chance of G1/Minor Storm intervals, either from lingering CME influence on Day 1, any further CME glance Day 2, as well as any coronal hole fast wind onset, particularly Days 2-3.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
24/1414	Partial	AR4000 and filament	NW	448	27/1800 UTC +/-12 hrs	Low confidence.

Figure 2: MOSWOC Enlil, which is significantly over estimating the current wind speed and is thought to be bringing in the fast wind from CH19 much too early.

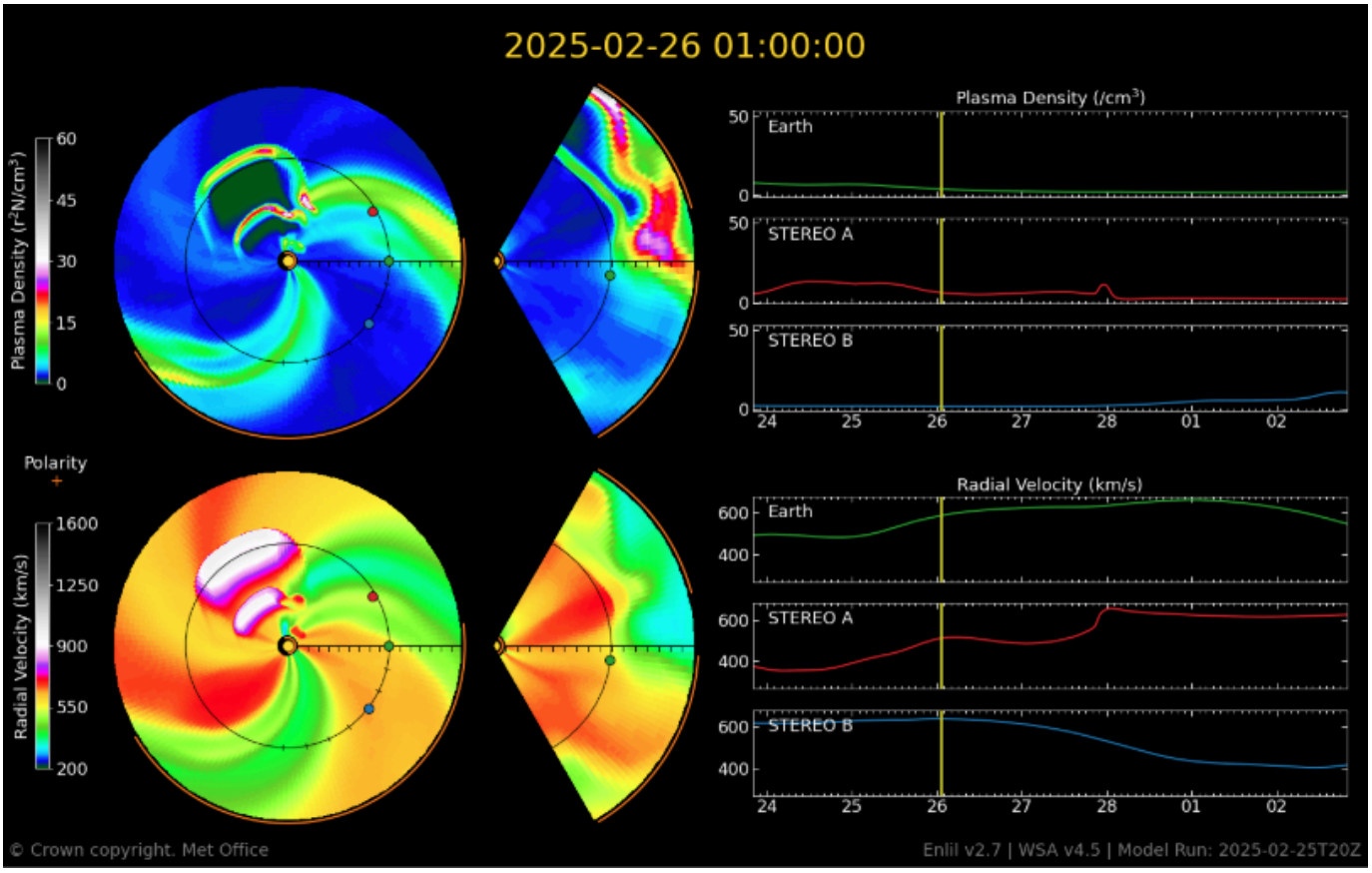

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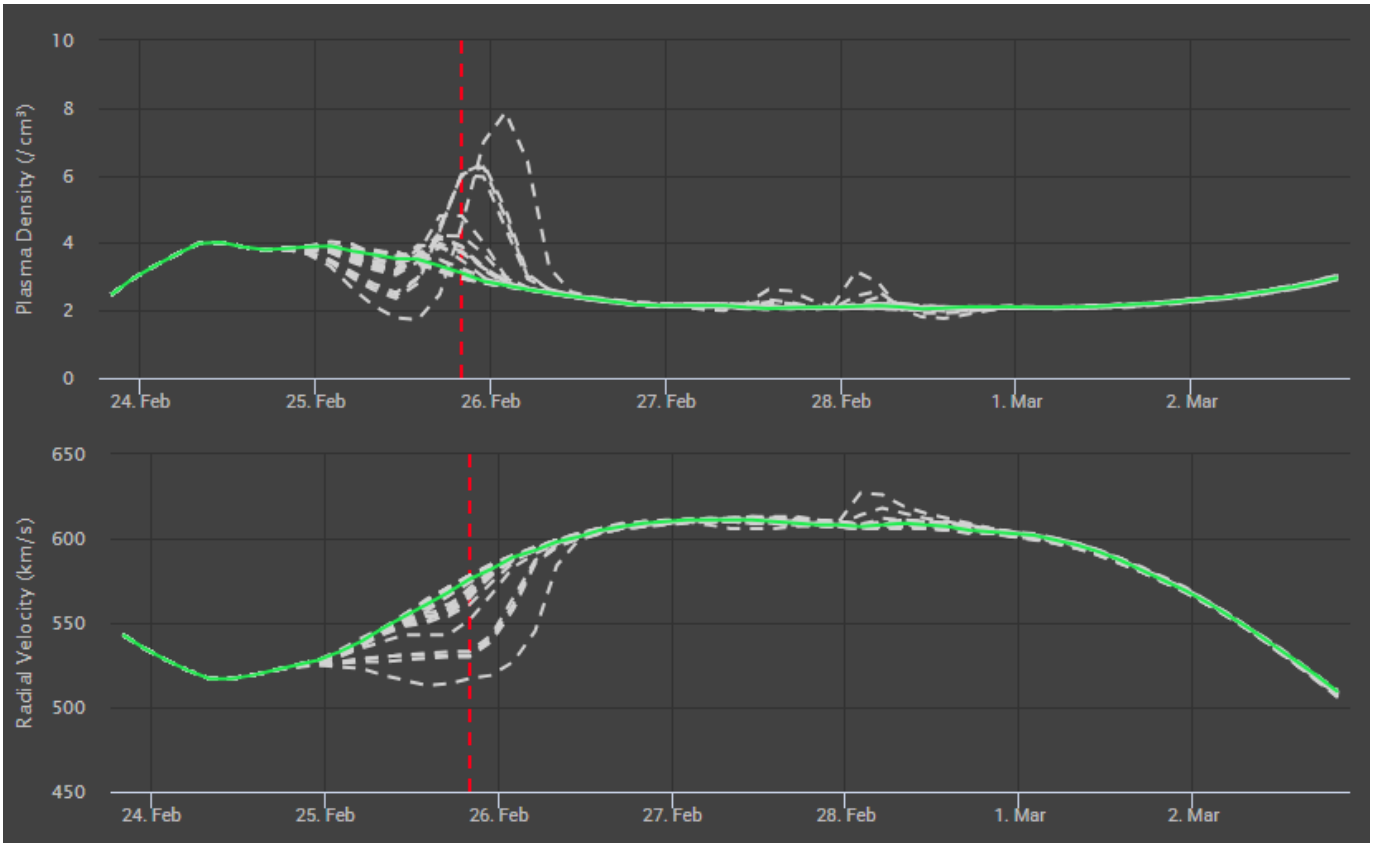
Figure 3: Enlil ensemble, with one or two hits from a low confidence CME 27-28 February.



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Radio Blackouts - X-Ray Flares

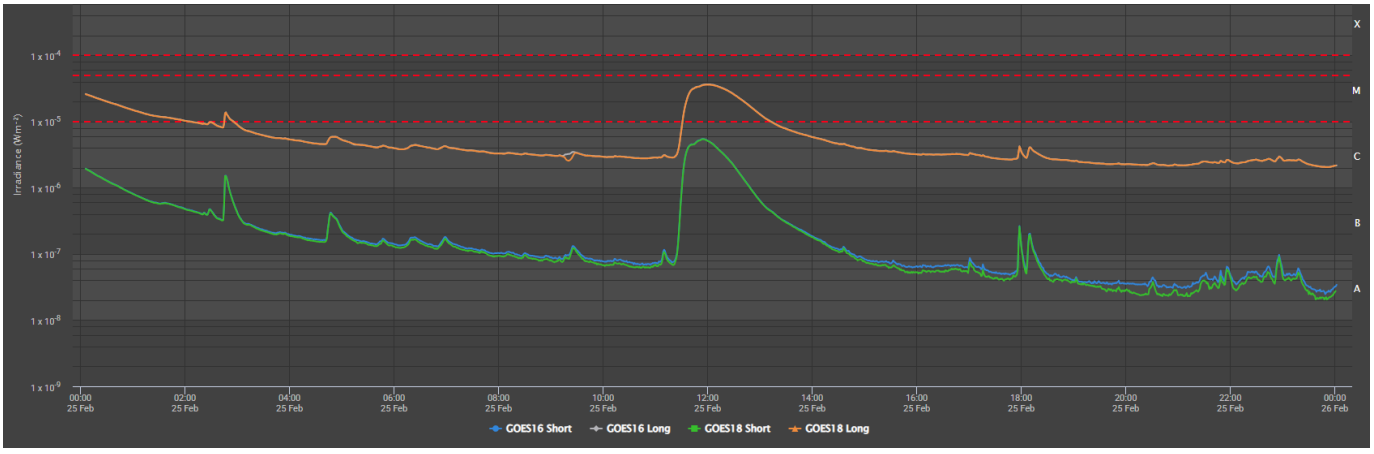
Solar activity has been Moderate with three M-class flares. A long duration flare from over the western limb peaked at 24/2306 UTC and was still above M-class at the start of the 24 hour period. A further long duration M3.6 was observed peaking at 25/1159 UTC, from the region of AR3998 and the trailer of AR3996.

There are now eight sunspot regions on the visible disc. The largest and most notable is AR3998 in the southwest, which is comprised of a number of small umbra, but maintains a larger bipolar configuration. There has been a slight loss of penumbral area, but a slight increase in length, with the leading spots in particular coalescing into a larger spot. The other regions of main interest include AR4000 in the northwest, but this continues to fade slowly. AR4006 in the northeast is also of note, with some intermediate spot development, but so far remains a relatively small region with only minor magnetic complexity. Other regions appear smaller and simple at the present time.

Of these eight regions, three of the larger ones are due to rotate off the disc in this period - AR3996 on Day 2, AR3998 on Day 3 and AR4000 on Day 4 (27 Feb-01 Mar). In addition, the regions over the west limb which have been the cause of much of the recent activity will also rotate further away from the limb. As such, activity is likely to be Moderate at first, with a slight chance of M-flares, but this risk reduces during the four day period.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	70	60	50
Very Active	R3-R5 (X Class)	No	10	10	10	5

Figure 4: X-ray flux at GOES16 and 18.



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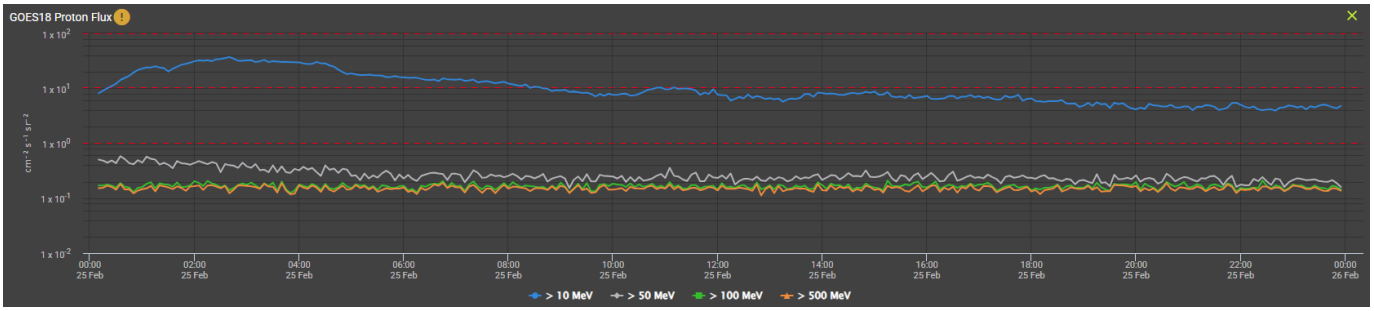
Solar Radiation Storms (High Energy Protons)

GOES-18 high energy (>10MeV) proton flux reached the S1/Minor Radiation Storm level due to the large far-sided eruption and subsequent flare of M3.9 peaking at 24/2302 UTC and visible from over the northwest limb. This has since declined, with the proton flux likely to continue easing towards background. There remains a reducing chance of renewed enhancements if any further far-sided activity occurs but the risk declines as these regions rotate away from the west limb. Some potential is maintained, however, due to AR3998 in the southwest, along with a number of other active regions on the Earth-facing disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	25	15	10	10
Very Active	**≥ S3 ***	No	5	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: Proton flux at GOES18, with the 10MeV protons reaching above the S1/Minor radiation storm threshold during 25 Feb but now declining.



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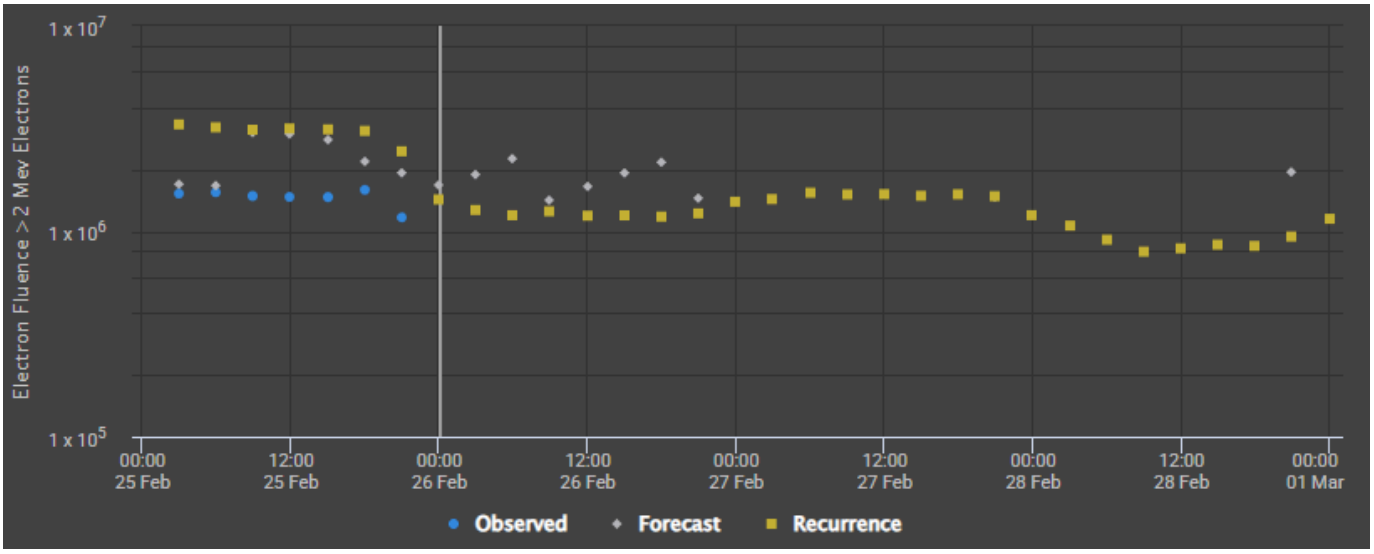
High Energy Electrons (≥ 2MeV)

High energy electron flux, as observed at GOES-16, is at background levels, with recent weak CME arrivals perhaps helping to suppress electron flux. Whilst the upcoming fast wind from CH19 (and perhaps CH18) has the potential to increase electron flux in the Van Allen belts later in the period, any response at GEO is expected to occur after the end of this forecast period.

The associated 24 hour fluence is currently below Active. This is expected to continue as suggested by MOSWOC REFM, which is currently providing reasonable guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM showing fluence well below the Active level.



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